Phys100: Exploring Physics: (sample syllabus)
Foundations of Quantum Physics for Regular People

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> *"Shut up and calculate!"—Richard Feynman or David Mermin?*
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> *"[Quantum mechanics is a] mysterious, confusing discipline, which none of us really understands but which we know how to use."*—Murray Gell-Mann
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> *"I think I can safely say that no one understands quantum mechanics."*—Richard Feynman
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> *"There are no analogies or pictures by which to understand quantum mechanics."*—Richard Feynman
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> *"Those who are not shocked when they first come across quantum theory cannot possibly have understood it."*—Niels Bohr
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> *"If you want to understand quantum mechanics, just do the math. All the words that are spun around it don't mean much."*—Freeman Dyson
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> *"The one thing that can be said against [quantum mechanics] is that it makes absolutely no sense!"*—Roger Penrose
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> *"The best that most of us can hope to achieve in physics is simply to misunderstand at a deeper level"*—Wolfgang Pauli

In this class we will attempt the impossible—we will attempt to understand the conceptual foundations of quantum mechanics. To add to the difficulty (and fun!) we will do so without using any more mathematics that a regular person would understand. This is not to say that the ideas discussed will not require some effortful thinking and courage—this is often a scary and forbidding topic given its unprecedented nature and the mathematical machinery involved. But if you remove the machinery, think about things in a new way, and allow for some inherent uncertainty and surprise, the "weirdness" of quantum mechanics melts but the fascination remains! As this class engages in this process it will shed light on contemporary scientific culture, some modern technologies, and many interesting and deep questions. For these reasons, understanding the ideas of quantum theory is becoming more and more of a necessity to be truly "well-educated."

So if you'd like training on how to be a top-notch arm-chair theorist—exploring the big ideas of our most powerful theory while avoiding the difficulties (and accountability) of mathematics—this class is for you!

> *"Like an adolescent reading Shakespeare, we feel the language of quantum phenomena to be at once strange and wonderful. The meanings are obscure, some words unknown. All the more reason to pause over it, to reread the text and muse over its possible meaning…Surely nature like a found dramatic script, deserves to be read for meaning and not merely acted out for profit…[E]verything depends on the courage and freshness of the reader."*—Arthur Zajonc

Text:

For each topic covered in the class, a relevant reading from an accessible scientific article or popularized book will be posted on Canvas.

In-Class:

In class we will listen to presentations (possibly by invited faculty), discuss the topics, and apply reasoning in an interactive way. Your attendance is required as a lack of viewpoints can significantly stifle the discussion.

Out of Class:

Students are expected to read the selected materials prior to class and formulate questions—even if it does not all make sense. This will prepare students for the in-class discussions. The readings will also provide valuable additional information, depth, and context. An online discussion forum will be used for students to keep in-class discussions going and to react to the readings. On this forum students will be expected to make *at least* two posts a week: one question from the reading prior to class and one reacting to the previous class discussion. Students are encouraged to interact with other's posts as well.

In the End:

At the end of the course, students will submit a short paper (2 pages max) reacting to and discussing one topic or aspect of the course. As students will often be asked to formulate their own opinions on some of the open topics we will discuss, the paper should be a reflection of the final sum of their thinking on a particular issue—they should take a position and present their (possibly personal) reasoning for taking it.

Tentative Schedule:

Week 1: The Nature of Science: what is quantum mechanics?
Week 2: The Postulates of Quantum Mechanics: knowing the rules of the game
Week 3: Measurement: finding answers and causing problems
Week 4: Complementarity: discovering the dual nature of things
Week 5: Complex Systems: what happens when you put things together?
Week 6: Decoherence: making sense of the madness
Week 7: EPR: Einstein's amazing mistake
Week 8: Bell's Theorem: a difficult decision from experimental metaphysics
Week 9: Competing Interpretations: Bohr, Bohm, and Everett…
Week 10: Psi-Ontology: is the wavefunction real?
Week 11: Quantum Cosmology: reunifying our view of the universe
Week 12: Wholeness: harnessing the unity in matter
Week 13: Applications: "nothing's more practical than a good theory"
Week 14: The Bigger Picture: does any of this *really* matter?

*Weeks 10-14 may be combined or replaced in order to make room for guest speakers.